Out-of-Hospital Combat Casualty Care in the Current War in Iraq

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The conclusions and opinions reported herein are those of the authors, and do not necessarily represent the official opinion of the U.S. Department of Defense or the United States Army.

Study objective: We describe outcomes for battle casualties receiving initial treatment at a US Army consolidated battalion aid station augmented with emergency medicine practitioners, advanced medic treatment protocols, and active medical direction. Battalion aid stations are mobile facilities integral to combat units, providing initial phases of advanced trauma life support and then evacuation. The setting was a forward base in central Iraq, with units engaged in urban combat operations.

Methods: This was a retrospective observational study. Rates of battle casualties, mechanism, evacuations, and outcome were calculated. Corresponding Iraqi theater-wide US casualty rates were also calculated for indirect comparison.

Results: The study population consisted of 1.1% of the total US military population in the Iraqi theater. Data were available for all battle casualties. The study facility's battle casualty rate was 22.2%. The case fatality rate was 7.14%, and the out-of-theater evacuation rate was 27%. Analysis of evacuated patients revealed a study average Injury Severity Score of 10 (95% confidence interval [CI] 8 to 12). Concurrent theater aggregate US casualty rates are provided for contextual reference and include battle casualty rate of 6.7%, case fatality rate of 10.45%, out-of-theater evacuation rate of 18%, and average out-of-theater evacuation casualty Injury Severity Score of 10 (95% CI 9.5 to 10.5).

Conclusion: The study battalion aid station experienced high casualty and evacuation rates while also demonstrating relatively low case fatality rates. A relatively high proportion of patients were evacuated out of the combat zone, reflecting both the battle casualty rate and number of patients surviving. Future effort should focus on improving out-of-hospital combat casualty data collection and prospective validation of emergency medicine–based out-of-hospital battlefield care and medical direction. [Ann Emerg Med. 2009;53:169-174.]

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INTRODUCTION

Combat casualty care takes place across a continuum from on-scene care ("point-of-wounding"), to mobile facilities with various capabilities, to fixed field hospitals.[1,2] Within this continuum, battalion aid stations are mobile medical facilities integrated into US Army ground combat units, such as infantry, cavalry, and armored (tank) and field artillery battalions and into corresponding combat units of the US Marine Corps.[3] They generally represent the first formal medical treatment facility that casualties may encounter as their care progresses.

The far-forward location of the battalion aid station limits medical capability to the initial phases of advanced trauma life support, including triage, airway management, fluid resuscitation, chest decompression, splinting, bandaging, and limited medications. They do not possess surgical capability. Standard staffing includes a primary care physician, 1 to 2 generalist physician assistants, up to 30 combat medics certified as National Registry of Emergency Medical Technicians-Basic (NREMT-Bs), and a medical service corps administrative officer, comprising a medical platoon.[3]

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Editor's Capsule Summary

What is already known on this topic

It is unclear what medical resources are necessary to optimize battlefield care and survival.

What question this study addressed

This retrospective case series compared outcomes of casualties treated at a battalion aid station staffed by emergency medicine–trained personnel versus theater-wide, aggregate data.

What this study adds to our knowledge

Despite higher battle casualty rates and out-of-theater evacuation rates, the study battalion aid station experienced lower case fatality rates when compared with aggregate data.

How this might change clinical practice

This study supports the hypothesis that the presence of emergency medicine specialists improved outcomes but does not prove it.

Despite their ubiquity and perceived importance to the overall military medical mission, little evidence exists to document the effectiveness of care rendered by the battalion aid station during modern warfare.[4] The purpose of this study was to describe the casualty epidemiology, medical treatment, and patient outcome experience of a battalion aid station engaged in combat operations during the current war in Iraq, with a primary focus on defining the rates of battle casualties, survival, injury severity, and evacuation. Potential implications for the provision of combat casualty care and medical planning will be highlighted.

MATERIALS AND METHODS

This study used a retrospective case series design, consisting of a quantitative review of records from a single consolidated battalion aid station during a 1-year deployment. Data were abstracted from computerized battalion aid station records generated prospectively at the study facility. The battalion aid station served 2 combat battalions and was located at an austere "forward operating" base in a major metropolitan area in central Iraq.

The study facility was staffed by 1 board-certified emergency physician and 1 emergency medicine physician assistant, in addition to 1 general pediatrician and 2 generalist physician assistants. This staffing model resulted when the respective units were colocated and their medical elements combined for on-base care. The emergency physician and emergency medicine physician assistant provided direct treatment and medical direction of combat medics and mentored the other practitioners as their skills in trauma care matured. This circumstance provided a novel opportunity to observe the possible effects of introducing emergency medicine specialty–skilled treatment and decisionmaking on patient outcome.

The inclusion criteria were all combat casualties undergoing medical treatment at the study facility from March 31, 2004, to February 15, 2005, for whom electronic medical record and outcome data were available. By nature of military practice, combat casualty demographic and epidemiologic records for virtually all incidents are captured, a fact that lent itself to facilitating the forthcoming analysis. This observation is counterpointed by the fact that detailed clinical information, such as vital signs, Glasgow Coma Scale score, and physiologic trends resulting from lifesaving interventions or deterioration, is not routinely captured in the current out-of-hospital combat casualty care setting.

Demographic, epidemiologic, and evacuation data were recorded. Relevant clinical data points collected included anatomic location and mechanism of wounding, field diagnosis, triage and evacuation category, out-of-hospital procedures performed, final diagnosis, survival, and clinical outcome. Outcome data were abstracted from daily casualty reports obtained from higher headquarters, other military treatment facilities, and autopsy data obtained from the Armed Forces Medical Examiner's office. A concurrent but unmatched comparison group consisting of all casualties reported in the Iraqi theater of operations for the study period was obtained and analyzed to provide a contextual reference.

Primary Data Analysis

Rates of battle casualties, killed in action, died of wounds, case fatalities, and out-of-theater evacuations were calculated in a manner consistent with Department of Defense guidelines.[5]

A battle was defined as a subject who was either killed or wounded as the result of hostile action. Killed in action was defined as a battle casualty who died before arrival at a field medical treatment facility. Died of wounds was defined as a battle casualty who died as a result of wounds at some point after arrival at a field medical treatment facility. Case fatality rate was defined as the sum of killed in action and died of wounds, divided by the total battle casualty rate. Out-of-theater evacuation was defined as a subject who required evacuation to military hospitals in either Germany or the United States for definitive care, recuperation, or rehabilitation. Out-of-theater evacuation occurred when a casualty could not undergo definitive treatment and attain the ability to return to duty within 72 hours of hospitalization.

Average census for the study facility and the total Iraqi theater US troop strength for the concurrent period were used as respective denominators for the rate calculations.[6] Injury Severity Scores (ISSs) for casualties who were treated at the study facility and who underwent out-of-theater evacuation were obtained from the Joint Theater Trauma Registry, which is maintained by the US Army Institute of Surgical Research in a fashion analogous to the American College of Surgeon's National Trauma Data Bank.

Corresponding battle casualty, killed in action, died of wounds, case fatality rate and out-of-theater evacuation were also calculated from concurrent aggregate Iraqi theater casualty data. This reference group was selected because corresponding data for other individual battalion aid station elements were unavailable for analysis.

Data were collected and maintained in accordance with institutional privacy safeguards. This study was reviewed and approved by the institutional human subjects review board of Brooke Army Medical Center, which has oversight responsibility for clinical research conducted in combat.

RESULTS

Data were available for all of the battle casualties encountered. During this period, the study population remained stable and comprised 1.1% of the total census of US troops deployed to the Iraqi theater of operations for the study period, as reported by the US Department of Defense.[6] No casualties were excluded from the analysis.

The combat units served by the study battalion aid station sustained a battle casualty rate of 22.2% and were treated at the study facility. Wounding mechanisms for the study sample included 21.5% gunshot wounds, 33.7% wounds sustained from roadside bomb explosions, 44.1% wounds from indirect fire munitions explosions, and 0.7% from hand-to-hand combat.

In the study sample, the killed-in-action rate was 5.47% and the died-of-wounds rate was 1.67%, yielding a case fatality rate of 7.14%. A total of 27% of our battle casualties were evacuated first to a field hospital and then out of the combat zone (out-of-theater evacuation) for definitive care. Analysis of all out-of-theater evacuation patients revealed a mean ISS of 10 (95% confidence interval [CI] 8 to 12).

Five soldiers died of wounds. One died at the study facility as the result of exsanguination from a traumatic total lower-extremity amputation for which hemostasis could not be obtained. The remaining 4 died-of-wounds soldiers survived evacuation to a field hospital but later died (2 sustained gunshot wounds to the head; 2 sustained gunshot wounds to the thorax and abdomen and experienced protracted field transport times before arrival at the study facility).

A total of 18 advanced airway procedures were performed (6% of wounded in action). Of these, 11 consisted of rapid sequence intubation with direct laryngoscopic orotracheal intubation, whereas 7 cricothyroidotomies were performed. The primary indications for cricothyroidotomy included time constraints involved in preparing the patient for rapid sequence intubation (2), maxillofacial trauma precluding standard laryngoscopy (2) or excessive secretions/blood or dental fragments in the posterior oropharynx that could not be cleared with available suction equipment (3).

There were 10 instances of chitosan hemostatic dressing use (3% of wounded in action). A total of 9 tourniquets were applied (3% of wounded in action). Six needle thoracentesis procedures were performed for decompression of suspected tension pneumothorax (2% of wounded in action), and 24 chest tubes were placed for pneumothorax or hemothorax (8% of wounded in action). HEXTEND (6% hetastarch in lactated electrolyte injection) intravascular volume expander (Hospira Inc., Lake Forest, IL) was administered on 24 occasions (8% of wounded in action). Indications for its usage were hemorrhagic shock associated with altered mental status.

As a means of contextual reference, we obtained and calculated the US forces' casualty, outcome, and evacuation rates corresponding to the entire Iraqi theater of operations during the period concurrent to this study. The aggregate theater-wide battle casualty rate was 6.7%, the case fatality rate was 10.45%, and the died-of-wounds rate was 1.5% (noteworthy because the latter was calculated after arrival and treatment at a field hospital with surgical capability). The out-of-theater evacuation rate for the entire Iraqi theater was 18%. ISS data for Iraqi theater aggregate out-of-theater evacuation casualties during the same period were obtained from the Joint Theater Trauma Registry in the same fashion as the study sample. Review of this data revealed a mean aggregate ISS of 10 (95% CI 9.5 to 10.5). Providing corroboration to this Joint Theater Trauma Registry data, Eastridge et al[7] reported a similar theater-aggregate average ISS of 9.9 (95% CI 2.4 to 17.4) for surviving casualties treated at field hospitals in Iraq from January to July 2004.

LIMITATIONS

This study shares all of the significant limitations inherent in a retrospective review of medical records and databases. Mitigating factors include a complete, sizeable, and nearly year-long database available for analysis. Nonetheless, our sample represents the observations of a single battalion aid station engaged in the current war in Iraq, and as such, its results may not be generalizable.

Currently, no comprehensive database of combat casualties exists within the US Department of Defense, nor elsewhere to our knowledge, that includes details of out-of-hospital care on the battlefield. This circumstance rendered it impossible to directly compare the study facility to other battalion aid station elements or other suitable matched controls; however, aggregate data for all combat casualties occurring in the Iraqi theater, and who were treated at field hospitals, were available. Such concurrent and aggregate casualty outcome data provided an opportunity for indirect comparisons; however, caution must be applied in making such comparisons because the study and aggregate groups would by nature be unmatched.

DISCUSSION

Care on the modern battlefield has evolved considerably since the Vietnam War era.[5] The current war in Iraq has seen the lowest killed-in-action rate of any protracted conflict involving US forces.[8] Improvement in protective body armor for ground troops is generally cited as the chief reason for this observation, with early damage-control surgery and rapid

evacuation out of the war zone being additional factors.[9-14] The effect of out-of-hospital care is likely to be an additional contributor, but confirmatory data are lacking.[4,12,15-19]

Outcomes research in civil-sector out-of-hospital care is sparse in general, and studies on combat casualty care are even more rarely reported.[20,21] Husum[22] describes a positive influence of advanced life support care in the Jalalabad, Afghanistan, battle of 1989 to 1992, whereas Korver,[23] who studied first aid stations with protracted evacuation periods in rural Afghanistan, reached a different conclusion. Other reports have tended to focus on single aspects of out-of-hospital combat casualty care or case series resulting from single engagements, such as the 1993 Mogadishu operation conducted by the US Special Operations Command.[24,25] As such, our study represents the first instance, to our knowledge, of a quantitative analysis of out-of-hospital care on casualty survival in the combat setting.

When taken together, the results of our comparison between the study sample and the concurrent Iraqi theater-wide US casualty reference group suggest several notable contrasts. The combat battalions supported by the study battalion aid station had more than 3-fold greater casualty rates; those casualties were nearly twice as likely to require out-of-theater evacuation for definitive treatment; and they had virtually identical ISSs, implying that the higher out-of-theater evacuation rate observed in the study sample was unlikely to have resulted from artifact. Yet, remarkably, the study sample had killed-in-action and case-fatality rates more than one third lower than that of the concurrent Iraqi theater-wide aggregate.

It is tempting to suggest that the improved study outcomes are somehow related to differences in the care provided. Indeed, the study battalion aid station was unique in that its staff contained a board-certified and experienced emergency physician and emergency medicine physician assistant. This contrasts with the standard staffing of more than 85% of concurrently deployed battalion aid station units in Iraq, composed of primary care physicians (predominantly pediatricians, internists, or family physicians) and generalist physician assistants (Army Medical Department, personal communication, 2005). Although the study battalion aid station differed by inclusion of the emergency medicine specialists, the total number of physicians, physician assistants, and combat medics assigned to the study facility was proportional to the total population of troops supported (2 battalions with additional attachments). This resulted in population-to-practitioner ratios essentially identical to the norm for maneuver battalions in combat (or roughly 300 to 1 for licensed practitioners and roughly 25 to 1 for combat medics),[3] which reduces the likelihood of any confounding effect based on the relative number of caregivers. Likewise, the amount and type of medical equipment, pharmaceuticals, and evacuation vehicles available to the study battalion aid station were the same. This latter observation offers some mitigation against potential confounding effects that would have resulted from technologic or transportation advantages over other battalion aid station facilities.

Bellamy[26] recently proposed a new set of casualty rates that may better characterize the true performance of medical units. He defines the "died-of-wounds mortality" and the "killed-in-action mortality" rates as the respective numbers of died of wounds and killed in action divided by the number of WIA not returned to duty within 72 hours. With this method, the study sample's died of wounds–mortality was 2.8% compared with a US Operation Iraqi Freedom-aggregate died of wounds–mortality of 5.3%, and the study killed in action–mortality was 12.9% versus an Operation Iraqi Freedom-aggregate killed in action–mortality of 16.1%.

The Vietnam era Wound Data and Munitions Effectiveness Team database remains the standard for combat casualty comparisons.[27] It identified the following conditions as primary causes of preventable death on the battlefield: airway obstruction (6%), tension pneumothorax (33%), and hemorrhage from extremity wounds (60%). Kelly et al[28] recently published a more recent retrospective analysis of autopsy records from the current war in Iraq and reported rates of preventable battlefield deaths for airway obstruction (10% to 15%) and extremity hemorrhage thought to be preventable by tourniquet (33%). Our data show comparable rates for the incidence of these conditions. A notable difference, however, is that virtually none of our subjects experienced death specifically because of these conditions after they were engaged by our medical elements. This finding may help explain our higher survival rate compared with overall theater battle casualty survival.

Other interpretations for the observed results are possible and cannot be excluded according to the available data. Local differences not accounted for (eg, individual wounding patterns and dynamics, evacuation times, leadership characteristics, expanded use of antibiotics) may be at play. Also, the aggregate combat zone data represent outcome after care at several types of medical units, some of which possessed initial "damage control" resuscitative surgical capability. Thus, an acknowledged risk in this analysis is the potential confounding introduced by differing levels of care on the battlefield. Because all such units have capability equal to or greater than that of a battalion aid station, it is logical to presume that such confounding would be more likely to suppress the differential between the study and aggregate groups, rather than amplify it.

Regardless of interpretation, direct comparisons must be approached with caution because the data for this study and the aggregate reference groups were derived separately. We are unable to definitively attribute any cause-effect linkage, given our study design. Nonetheless, these striking differences in outcome between the study sample and aggregate casualty reference group provide a worthy vehicle for a healthy discussion on the effectiveness of out-of-hospital combat casualty care and the methods to improve it.

If we assume that the baseline condition of the soldiers and the case mix of the injuries in the study sample were comparable to that of Iraqi-theater aggregate US casualties, this study suggests that battle casualty survival might be improved by placing better-trained physicians and physician assistants in battalion aid station units. Even if this postulate is rejected, common sense argues that medical personnel expected to resuscitate and transport severely wounded casualties should have commensurate training and experience. Additionally, expert medical direction provided to the combat medics may also indirectly improve patient care outcomes.[29] Certified emergency physicians and emergency medicine physician assistants possess the specific clinical skills needed for combat resuscitation and medical direction of combat medics, a fact that was recognized in the Army's proposed combat health support plan in the 1980s.[30] Other physicians, such as trauma surgeons, might also successfully fill these positions; however, assignments of any specialists must be tempered by the limited supply of such personnel and by the complexity required to train their replacements.[16,30]

The Army has long recognized the training gap of generalists assigned to positions requiring acute trauma resuscitation and has endeavored to mitigate it. The recently instituted Tactical Combat Casualty Care initiative provides both a standardized clinical guideline and a complimentary training course for conducting the initial phases of out-of-hospital combat casualty care. In addition, a series of short courses is offered for combatant unit and field hospital medical staffs in the period immediately before combat deployment. Examples of these courses include the Advanced Trauma Life Support curriculum, the Brigade Combat Team Trauma Training Course, and the Joint Forces Combat Trauma Management Course. Although they provide a helpful construct, such "just-in-time" training cannot compare with the criterion standard of residency training and board certification.[31] Also, in practice, some deploying units are unable to attend these predeployment programs because of time constraints and logistic and other issues.

Competency and quality can be neither demonstrated nor improved without data collection and documentation. In the current US combat casualty care system, patient-related clinical data collection is not required before arrival at a surgical facility. As a result, the availability of such data is severely limited, a fact reflected in this study by the lack of an available matched comparison group. An unintended consequence of such missing documentation is that the potential effects and deficiencies in out-of-hospital interventions are obscured, rendering critical analysis and evidence-based program improvement impossible. Thus, regardless of how our other findings might be interpreted, the current study has demonstrated both the feasibility and the potential value in collecting out-of-hospital combat casualty clinical data. It now remains for the military research and development community to seek facile, reliable, and accurate mechanisms for collecting and analyzing these data on a system-wide scale.

The military continues to strive for improved combat casualty care. Notable developments include enhanced en-route care capabilities and a systems approach to combat trauma care not unlike the familiar civilian model. We strongly recommend that these advances be extended to include the out-of-hospital component to maximize effectiveness.[32]

In conclusion, we report the results of a year-long retrospective case series of combat casualties receiving emergency medicine specialty–based out-of-hospital care during high-intensity urban combat operations in the current war in Iraq. The study population experienced high casualty and evacuation rates while demonstrating relatively low case fatality rates. A high proportion of patients were evacuated out of the combat zone, reflecting both the higher battle casualty rate and the relative number of patients surviving. Future effort should focus on improving out-of-hospital clinical data collection for combat casualties, with the intent of measuring effectiveness and driving innovation toward improvement of the care delivered there. In addition, prospective studies to validate the apparent salutary effect of emergency medicine–based out-of-hospital battlefield care and medical direction are warranted.

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